MS3ST5/10-S

3 Phase Step Motor Drive

User Manual

SHANGHAI AMP & MOONS' AUTOMATION CO. LTD.

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1 Introduction

1.1 Overview

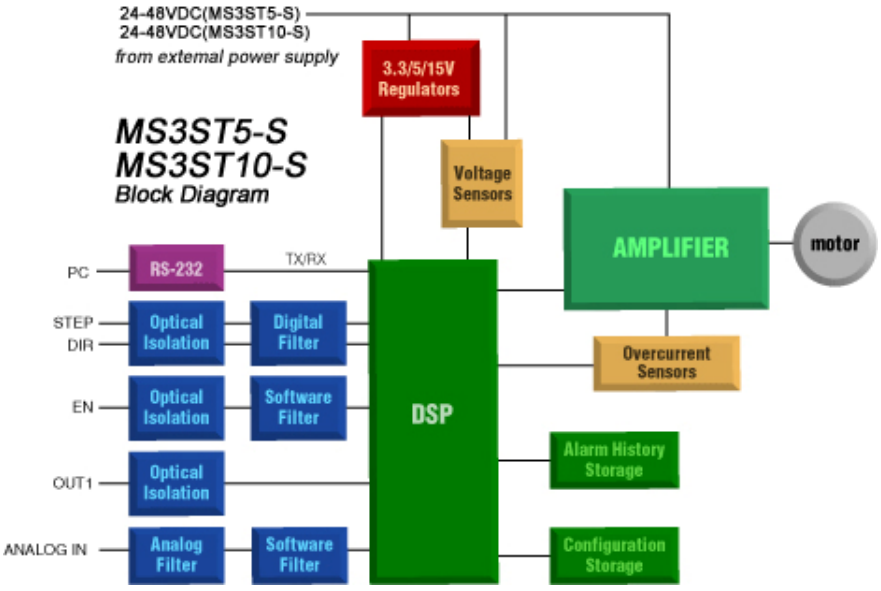
Thank you for selecting a MOONS' motor drive. We hope our dedication to performance, quality and economy will make your motion control project successful.
If there's anything we can do to improve our products or help you use them better, please call (86)21-52634688 or fax (86)21-62968682. You can also email info@moons.com.cn.

1.2 Features

- Brand-new technology
  - Advanced current control
  - Microstep emulation provides smooth motion even with low step resolutions
  - Anti-resonance algorithm eliminates mid-range instability
  - Command signal dynamic smoothing algorithm make motor motion less jerky
- Multiple operating modes
  - Step & Direction
  - CW/CCW
  - Encoder following
  - Analog velocity or digital velocity
  - SCL "host" commands for real time control from a host PC or PLC using RS-232 serial communication
- Multi-axis Mis programming when used with MisNet Hub
- RS-232 communication interface
- Software selectable microstep resolutions from 200 to 51200 steps/rev. in increments of 2 steps/rev.
- Power supply: External 24-48 VDC (MS3ST5-S)/24-80 VDC(MS3ST10-S)
- Software selectable motor current 0.5-5(MS3ST5-S)/0.5-10)MS3ST10-S) amps/phase in 0.01 amp increments
- Auto setup measures motor parameters and optimizes system performance automatically
- Automatic idle current reduction from 0 to 90% of full current after a delay selectable in milliseconds
- Inputs & Outputs
  - One 0-5V analog input
  - Two 5V high-speed digital inputs
  - One 5-12V digital input
  - One 24V@10mA(max.) optical isolated digital output
- Strong protection: over-voltage, under-voltage, over-temp and over-current.
- Compact size
- Suitable to drive 3 lead NEMA 24 or 34 three phase step motors
- CE Certification
- RoHS Compliant

1.3 Block diagram

The block diagram of MS3ST5/10-S is as below



1.4 Specifications

POWER AMPLIFIER SECTION: -S

AMPLIFIER TYPE	MOSFET , Three half Bridge, 4 Quadrant
CURRENT CONTROL	4 state PWM at 20 KHz
OUTPUT CURRENT	MS3ST5-S: 0.5- 5.0amps/phase (peak value) in 0.01 amp increments MS3ST10-S: 0.5 - 10.0amps/phase (peak value) in 0.01 amp increments
POWER SUPPLY	MS3ST5-S: External 24 - 48VDC Power Supply Required MS3ST10-S: External 24 - 80VDC Power Supply Required
INPUT VOLTAGE RANGE	MS3ST5-S: 18 - 53 VDC MS3ST10-S: 18 – 88 VDC
PROTECTION	Over-voltage, under-voltage, over-temp, motor/wiring shorts (phase-to-phase, phase-to-ground).
IDLE CURRENT REDUCTION	Reduction to 0-90% of full current after a delay selectable in milliseconds

CONTROLLER SECTION: -S

NON-VOLATILE STORAGE	Configurations are saved in FLASH memory aboard the DSP
MODE OF OPERATION	Step & Direction, CW/CCW, Encoder Following, Oscillator, Joystick, SCL
STEP AND DIRECTION INPUTS	Optically Isolated, Differential, 5 Volt. Minimum pulse width = 250 ns. Maximum pulse frequency = 2 MHz
	Function: Step & Direction, Run/Stop & Direction, Jog CW/CCW or CW /CCW Limits
EN INPUT	Optically Isolated, 5-12 Volt
	Function: Motor Enable, Speed Select, Alarm Reset or Home Switch
OUTPUT	Optically Isolated, 24V, 10mA MAX
	Function: Fault, Motion, Tach, or Brake

SPEED RANGE	Depends upon selected resolution. Amplifier is suitable for speeds up to 50 rps
ANALOG INPUT RANGE	0 to 5V
MICROSTEP RESOLUTION	Software selectable from 200 to 51200 2 steps/rev increments
ANTI RESONANCE	Raises the system damping ratio to —0.3 to 0.5; eliminates midrange instability and allows stable operation to 50 rps
AUTO SETUP	Measures motor parameters and configures gain parameters
MICROSTEP EMULATION	Performs low resolution stepping by synthesizing coarse steps from fine microsteps
COMMUNICATION INTERFACE	RS-232
AMBIENT TEMPERATURE	0 to 55°C (32 - 158°F)(MS3ST10-S must be mounted to suitable heatsink)
HUMIDITY	90% non-condensing

1.5 Getting Started

To use drive models MS3ST5-S or MS3ST10-5, the following items are needed:

- ✧ A power supply (24-48VDC for MS3ST5-S and 24-80VDC for MS3ST10-S)
- ✧ A compatible step motor
- ✧ A small flat blade screwdriver for tightening the connectors - a MOONS' screwdriver suitable for this purpose is included with your drive
- ✧ A PC running Windows 98,2000,ME,XP or NT with a 9 pin serial port
- ✧ The *ST Configurator software* included with the drive
- ✧ The communication cable included with the drive

To become familiar with the ST drive and Configurator Software before utilizing it in an application, the following steps are recommended:

1. Install the *ST Configurator Software* from the CD
2. Launch the software by clicking **Start**...**Programs**...**MOONS'**...**ST Configurator**
3. Connect the drive to your PC using the programming cable supplied
4. Connect the drive to the DC power source (may be switched)
5. Connect the drive to the motor
6. Apply power to the drive
7. Follow the instruction in the *ST Configurator Software*

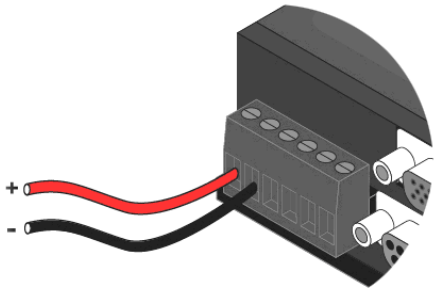
2 Installation

2.1 Connections wires

2.1.1 Connecting the power supply

The MS3ST5-S accepts a DC supply voltage from 24 to 48 VDC. The MS3ST10-S accepts a DC supply voltage from 24 to 80 VDC.

Using the connector supplied and AWG 16 or 18 wire, connect to the power supply as in the diagram below.



Fusing

Internal fuse: the MS3ST5-S and MS3ST10-S contain internal 10 amp fast acting fuses

External fuse (optional): if desired, we recommend:

MS3ST5-S	MS3ST10-S
3AG, 4 amp	3AG, 6.25 amp
Littlefuse 313004P	Littlefuse 3136.25P

Be careful not to reverse the wires. Reversing the connections may destroy the drive and void the warranty.

Choosing a Power Supply

Voltage

A power supply with a voltage rating at least five times that of the motor is necessary for efficient and silent switching. Higher speed needs will require even more voltage. However, the required voltage will not exceed 48V for the MS3ST5-S or 80V for the MS3ST10-S.

If an unregulated power supply is used, it should not exceed 34V for the MS3ST5-S or 57V for the MS3ST10-S due to the fact that unregulated supplies are rated at full load current. At lower load as when the motor is not moving, the actual voltage can be as much as 1.4 times the rated voltage. For smooth, quiet operation a lower voltage gives the best results.

Current

The maximum supply current required is the sum of the two phase currents. The requirements will generally be less than that, depending on the motor type, voltage speed and load conditions. This is due to the switching amplifiers present in these drives which convert high voltage and low current into lower voltage and higher current. As the power supply voltage exceeds the motor voltage, less current is required from the power supply. A motor running from a 48 volt supply can be expected to draw only half the supply current that it would with a 24 volt supply.

To select an appropriate power supply, the following procedure is recommended:

1. If only a few drives will be used, a power supply with at least twice the rated phase current of the motor is needed.

2. When designing for mass production at low cost, current requirements may first be determined by using the power supply recommended above. The motor should be installed in the application and monitor the current coming out of the power supply and into the drive at various motor loads. An appropriate power supply can then be selected.

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coming out of the power supply and into the drive at various motor loads. An appropriate power supply can then be selected.

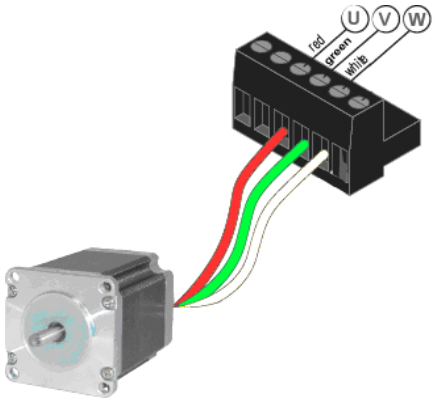
Regeneration

When a step motor decelerates, it converts the kinetic energy of the load into electrical power, much like a generator. Some of this power is consumed in the motor and some in the drive. In applications involving large loads running at high speeds, considerable energy is transferred to the power supply. Generally, simple, linear power supplies have large capacitors capable of absorbing this energy without damage. Switching power supplies usually shut down due to an over voltage condition. Excess energy is then transferred back to the drive and can damage it. To prevent this, the use of an RC-50 regen clamp is recommended as illustrated below.

2.1.2 Connecting the Motor

Never connect the motor to or disconnect it from the drive the power is on. Insulate unused motor leads separately, and then secure. Never connect motor leads to ground or to a power supply.

A 3-phase step motor's winding is either a star or delta configuration. A delta connection is best for high speed applications, while a star connection is best for low speed. The MS3ST drives are set up for delta connection. Connect the motor leads to the drive screw terminals U, V, and W. You can also reverse any two leads to change the motor's running direction.



(The star and delta wiring diagrams need to be included for further understanding.)

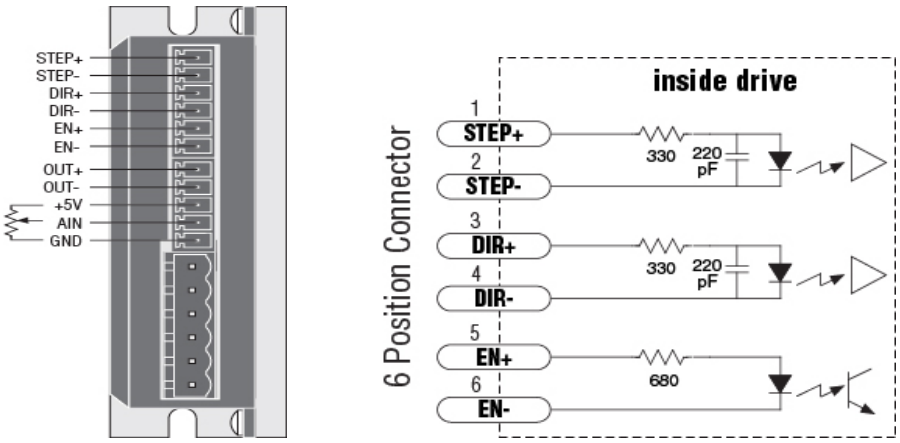
2.1.3 Connecting to the PC using RS-232

Position the PC within 6 feet (1.83 meters) of the step drive. Locate the black adapter plug that came with the drive. Plug the large end of the adapter into the COM1 serial port on the PC. Secure the adapter with the screws. If the COM1 port is already in use, the COM2 port may be used. If the COM2 port has a 25 pin connector and this port must be used, purchase a 25 to 9 pin serial adapter. Another option is to use a USB port via a USB to RS-232 adapter.

2.1.4 Connecting the inputs and outputs

The three inputs (STEP, DIR, EN) are on the six position connector. The analog input and the digital output are on the five position connector along with 5VDC and a ground for analog connections.

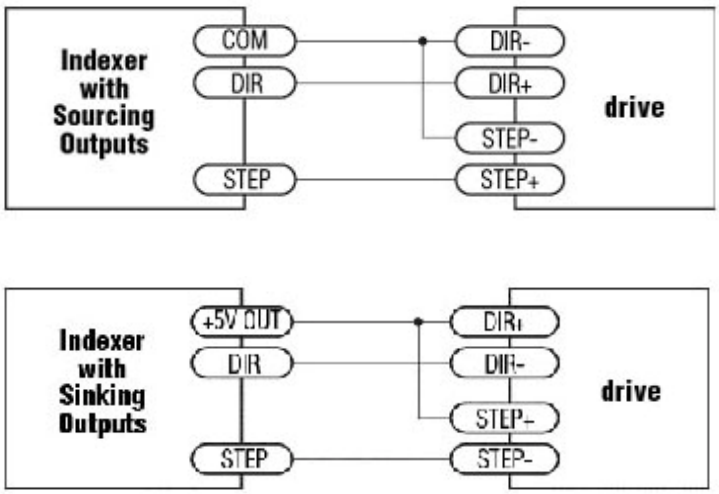
（1）connecting digital inputs

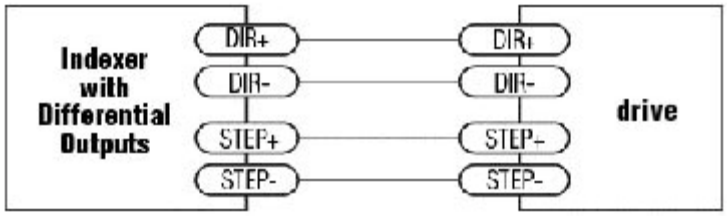


Digital inputs

The S drives include two high speed inputs called STEP and DIR. They accept 5 volt single-ended or differential signals, up to 2 MHz. EN is a 5-12V standard digital input that can be used for motor enable.

Indexer connections



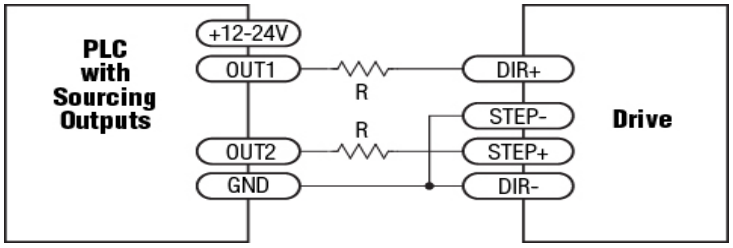


Using High Speed Inputs with 12-24 Volt Signals

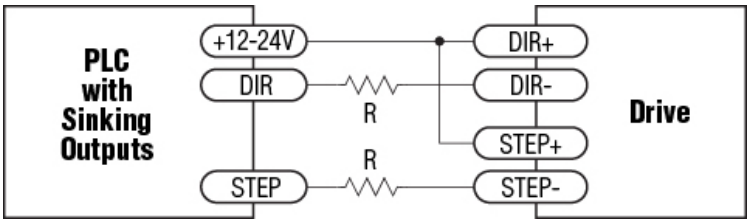
PLCs do not commonly use 5 volt logic. Signal levels as high as 24 volts may be connected to the STEP and DIR inputs if external dropping resistors are added as shown below:

- For 12V logic, add 820ohm, 1/4 watt resistors
- For 24V logic, add 2200ohm, 1/4 watt resistors

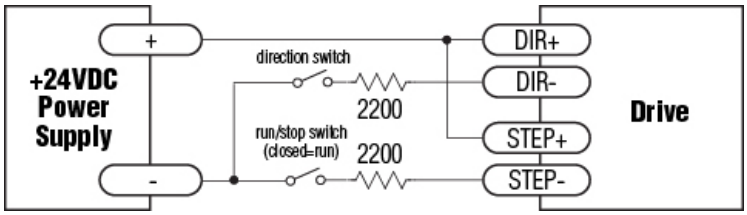
Warning: The maximum voltage that can be applied directly to a high speed input terminal is 5 volts. Never apply high voltage AC to an input terminal.



Connecting to PLC with Sourcing (PNP) Outputs
(Most PLCs use 24V logic)



Connecting to PLC with Sinking(NPN) Outputs
(Most PLCs use 24V logic)

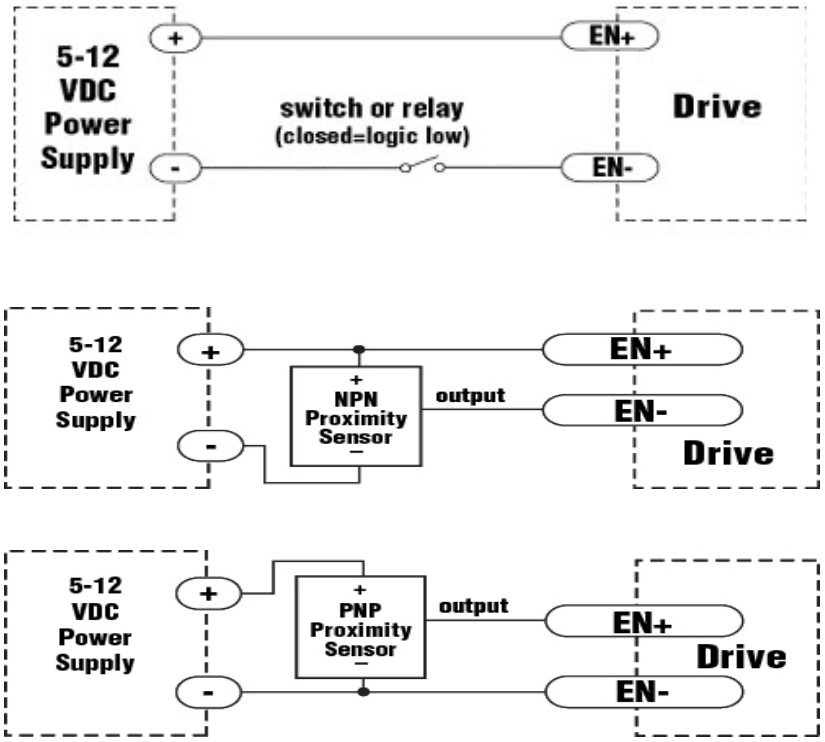


Using Mechanical Switches at 24V

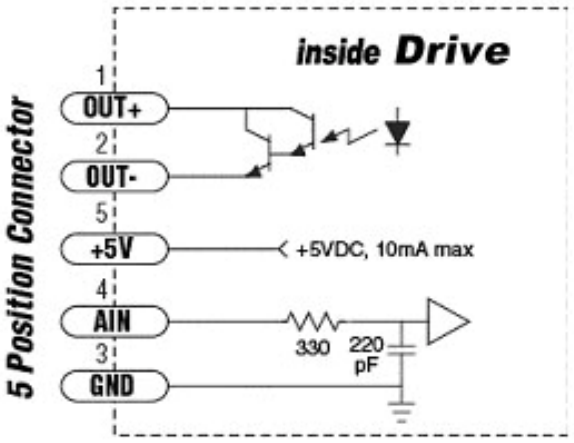
Standard Digital Input

As mentioned above, the STEP and DIR inputs are configured for 5 volt logic. The EN input is designed for operation between 5 and 12 volts. Add 1500ohm to EN for 24 volt operation.

EN Input Connection Examples

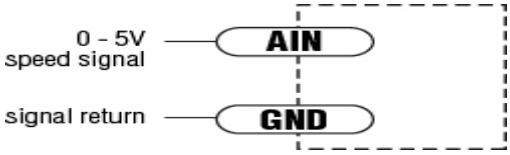


（2）Connecting Analog Inputs

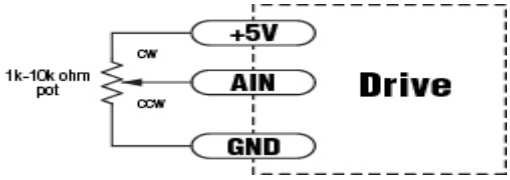


The MS3ST has one 0 to 5 volt analog input that can be used by the drive for controlling the motor speed in velocity mode.

Connecting an Analog Signal



Connecting the Analog Input to a potentiometer or joystick



WARNING: The analog input must be used with care. It is not optically isolated and may operate improperly or could be damaged when system grounds are not compatible.

(3) Connecting the Digital Output

The MS3ST5-S and MS3ST10-S drives include one digital output that can be used in one of five ways:

Brake: Brake: controls an electric brake relay, automatically releasing and engaging as the drive requires

Motion: indicates when the motor is moving

Fault: closes when a drive fault or alarm condition occurs. The red and green LEDs will flash an error code

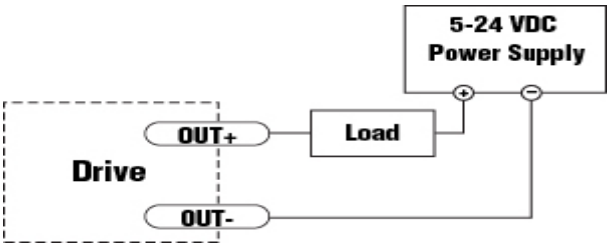
Tach: produces pulses proportional to the distance traveled (and thereby a frequency that is proportional to motor speed)

General purpose: digital output controlled by the SCL SO, FO, IL and IH commands.

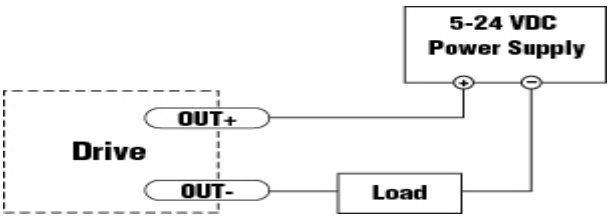
The output has separate + and - terminals and can be used to sink or source current.

Diagrams of each type of connection follow.

Do not connect the outputs to more than 24VDC.
The current through each output terminal must not exceed 10 mA.



Sinking Output



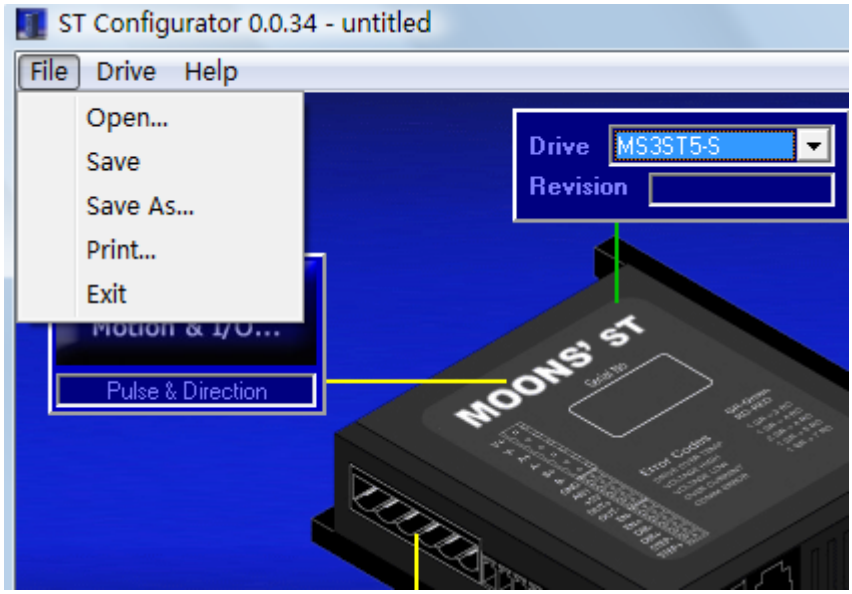
Sourcing Output

2.2 Configuration

With the ST Configurator (versions 0.0.034 or above) drives can be configured for specific applications. The setup is divided into four sections, each focused on a particular area of configuration.

2.2.1 Configurator Menus

In the **File Menu** previously created configurations can be Opened and new or altered configurations can be Saved. Any setup can be Printed. The Exit command will close the ST Configurator.



The **Drive menu** provides three features: the *SCL Terminal* allows you to type in SCL commands and see the drive's response. For SCL applications, this is a good way to learn the commands before you start writing your host control software.

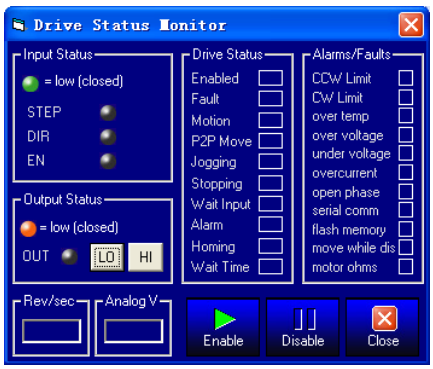
Alarm History will display the last eight alarms and/or faults. If an alarm or fault condition is being displayed, Clear Alarm will clear it. Restore Factory Defaults will return the drive to its original factory configuration.

SCL Terminal allows SCL commands to be entered to test the drive's response, creating an opportunity for commands to be learned before host control software is written.

Self Test rotates the motor a half revolution in alternating directions at a low speed to allow verification that the motor is connected and functioning properly.

Status Monitor displays real time drive status including:

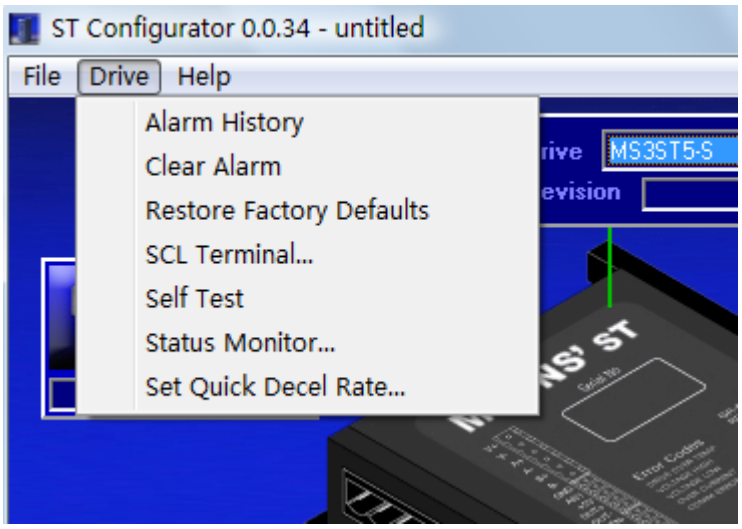
Status Monitor



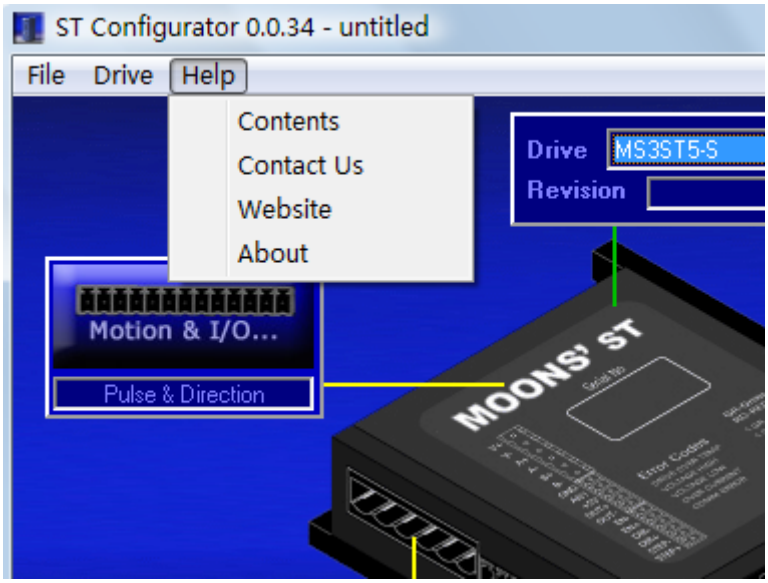
The status Monitor displays real time drive status including the following: accessed from the Drive menu, displays real time drive status including:

- State (open or closed) of all inputs
- State of outputs (click the HI/LO buttons to force an output)
- Motor speed
- Voltage at the analog input
- Alarms or faults
- Status flags (enabled, motion, jogging, etc.)

The motor can be enabled or disabled from the Status Monitor by clicking the buttons at the bottom of the display.



The **Help Menu** allows access to the help screens via Contents, gives Contact information for MOONS', links the user to the Website, and gives technical information about ST Configurator.



2.2.2 Drive

Choose one of the ST drive models from the drop down list on the upper right. The MS3ST5-S and MS3ST10-S can be used for three types of applications:

1) Applications where another device controls the drive by sending electrical signals over wires. The signals can be digital positioning pulses (step & direction or quadrature encoder following modes) or a velocity mode where the motor speed is selected by digital or analog signals.

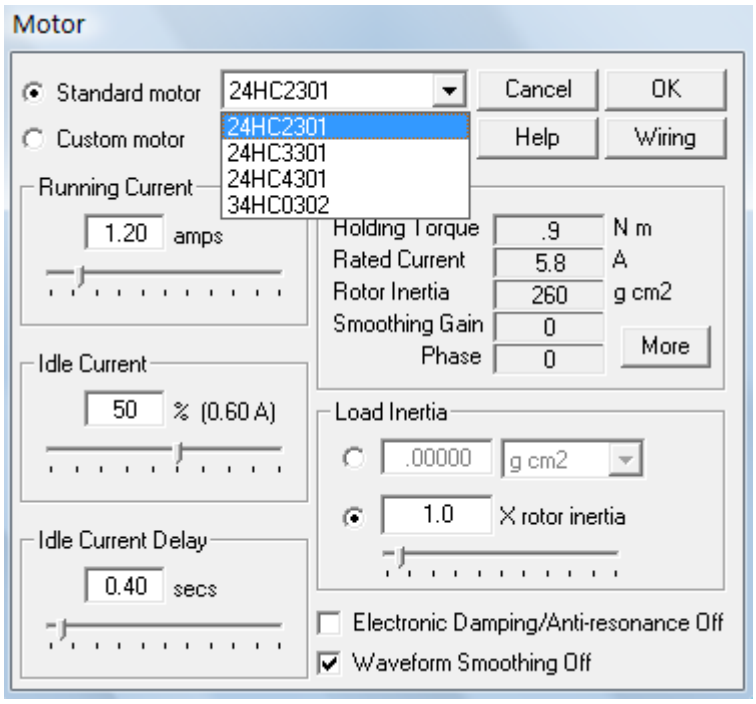
2) Applications where a host PC or PLC sends high level commands over a serial port using the Serial Command Language (SCL)

3) Multiaxis applications where a control program is stored in a MisNet Hub and one or more drives are connected to it.

2.2.3 Motor

In the Motor dialog box, operational parameters are defined, either by choosing a motor from the database, or entering information about a custom motor.

Configuring the Motor



The ST drives work best with the recommended specially matched motors. To configure the drive for one of these motors, select it from the drop down Standard Motor list. The Rated Current for the selected motor will appear in the Motor Specs section. If an application is particularly heat sensitive and there is more torque available than needed, motor heating may be reduced by lowering the current. If a duty cycle is short, giving the motor time to cool down between moves, the current may be set higher than rated to increase the torque. However, motors operated above their rated current will not run as smoothly, and, if used continuously, could overheat.

Reducing the Idle Current reduces motor heating by lowering the current when the motor is at rest. In most cases, the default value of 50% works well. Motor heating may be further reduced by lowering the Idle Current percentage even more.

The Idle Current Delay is the amount of time between when the motor stops and the current is reduced. It is recommended to allow a little time for the motor to settle out before the current is reduced.

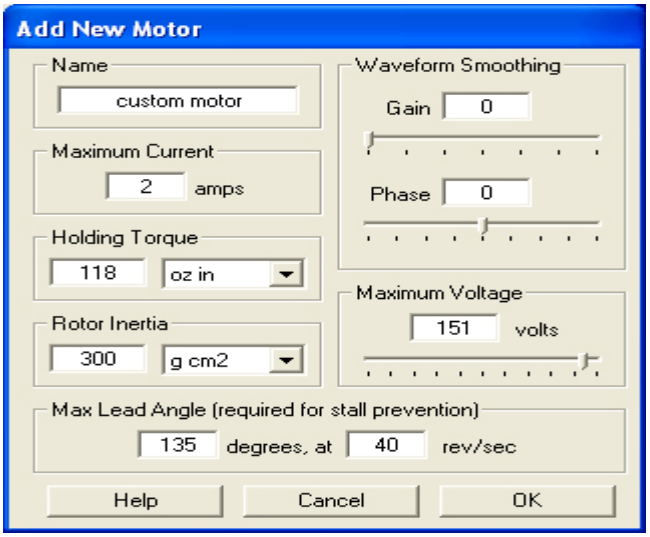
Note: The Rated Current is in RMS formal and the Running Current is the peak value. The Running Current must not exceed 1.5 times the Rated Current.

Load Inertia

The anti-resonance feature is most effective if the load inertia is set precisely. If this is a known value, the first option circle should be clicked, the inertia entered, and units of measurement selected. If the exact inertia is not known, the second option circle should be selected and an approximate load to motor inertia ratio entered. This number can be adjusted as needed.

Defining a Motor not in the Recommended List

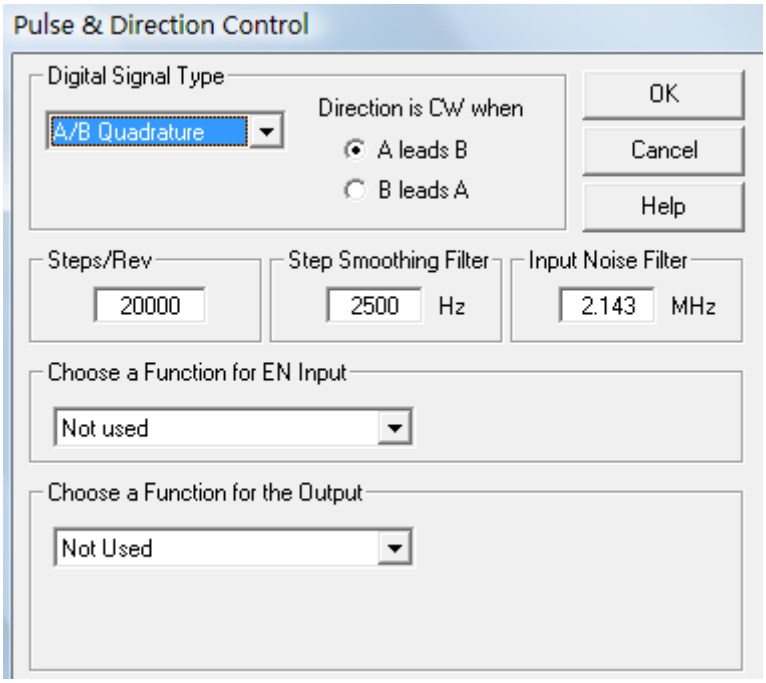
When a Custom Motor is used, detailed information from the manufacturer will be needed. This includes electrical specifications (holding torque, rated current and rotor inertia) as well as a wiring diagram. To define a Custom Motor, that circle should be checked and the Define Custom Motor button clicked. In the Add New Motor dialog box, current, torque and inertia values are entered. For the smoothest motion, the harmonic distortion gain and phase should be entered. This may need to be determined by running the motor at a slow speed (1 rev/sec) with different gain and phase values until the desired effect is achieved. If the values are not known or determined, gain and phase may be set at 0.



2.2.4 Motion

Clicking on the Motion button will bring up the Motion menu where one of several operating modes may be selected. Digital Positioning (Pulse/Dir), Velocity (Oscillator), SCL, and Hub are the modes available for the S drives.

Digital Positioning Mode



Pulse Input Mode is for systems where the position of the motor is determined by a digital input signal in the form of pulses.
The three modes available are :

Pulse and Direction. A signal such as that generated by a step motor controller is used. In this mode, the frequency of the pulses fed into one input determines the speed of the motor. Direction of rotation is determined by a signal fed into another input. Either an ON or OFF signal can be configured to represent clockwise motion.

CW and CCW Pulse. The drive has two inputs allocated to this feature and the motor will move CW or CCW depending on which input the pulse is fed into.

A & B Quadrature. This is sometimes called "Slave Mode." Signals fed to the drive from a master encoder control the movement of the motor. The encoder may be mounted on a shaft on the machine or can be another motor in the system. With quadrature input, it is possible for a number of motors to be "daisy chained" together with the encoder output signal from each drive being fed into the next one.

For all the Pulse Input modes you will need to determine a value to enter into the Electronic Gearing Box, an explanation on how to do this is given in the next section.

Steps/Rev

Steps/Rev allows adjustment of the way the drive responds to incoming step pulses. If a step motor drive in an existing application is being replaced with a new drive, here the new drive can be configured to have the same number of steps/rev as the old one.

In a new application, this value should be entered in accordance with the pulse source or indexer. The motor will provide smoother, more precise motion with a higher step count, but when the frequency of the indexer is limited, the steps/rev may need to be reduced to achieve the desired speed range. For example, in an

application requiring a maximum speed of 20 revs/second where the indexer is limited to a 100kHz maximum pulse rate, the steps/rev should be no higher than 5000.

A particular value may also be entered to make one step result in a convenient increment of motion. For example, in a linear motion application using a lead screw with a pitch of 5 turns per inch, 20,000 steps/rev will provide a nominal movement of .00001 inches per step. Move lengths can be more easily calculated with this method. For a metric application with the same lead screw, 50,800 steps/rev would result in . 0001 mm per step.

Encoder following applications can also be easily configured with a particular Steps/Rev value. To drive the motor two turns for every one turn of a 2000 count/rev (500 line) encoder, the value of 1000 steps/rev would be entered.

Other I/O Settings

Functions can also be assigned to the EN input and the output in the Pulse & Direction Control box.

Options for the EN Input are:

- ***Enable motor when closed*** - current flowing through the input enables the motor and it has no power when the input is open
- *Enable motor when open* - opposite of above
- *Reset alarm when closing* - an alarm or fault can be cleared by closing the input
- *Reset alarm when opening* - an alarm or fault can be cleared by opening the input
- *Not Used* – there is no function for the input, but its state can be read using the SCL IS, FS or FY command.

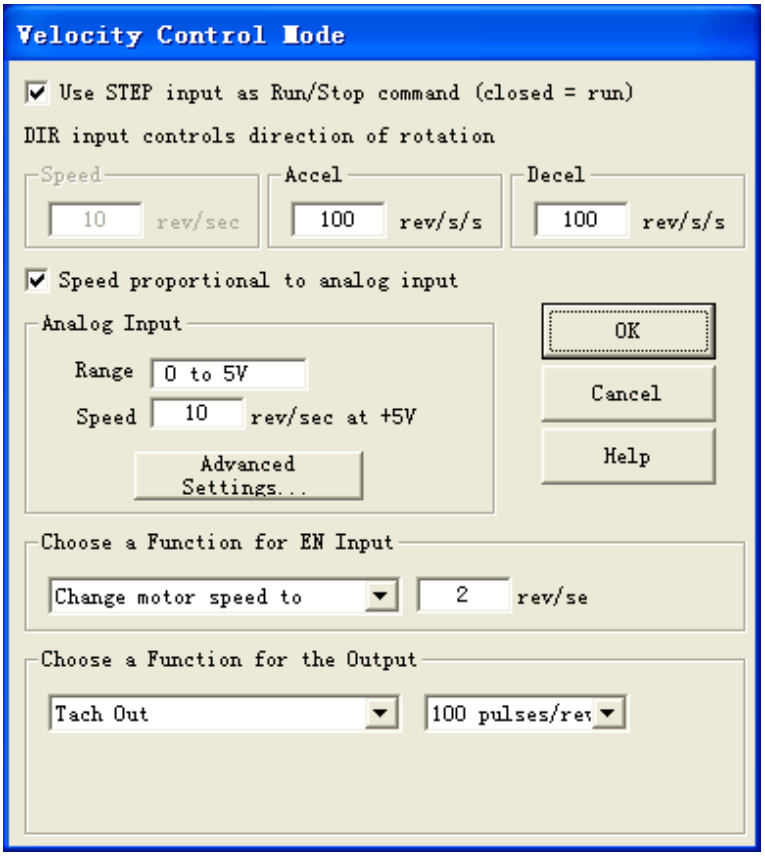
Options for Output are:

- *Closed on fault* – the output will close if a fault occurs
- *Open on fault* – the output will open if a fault occurs

- *Closed to release brake* – the output controls a fail safe brake relay
- *Open to release brake* – the output opens to release the brake
- *Closed when moving* – the output closes whenever the motor is moving
- *Open when moving* – the output produces pulses relative to the motor position
- *Tach out* - output produces pulses relative to the motor position
- *Not Used* – there is no function for the output, but it can be controlled using the SCL SO, FO, IH and IL commands.

Velocity Mode

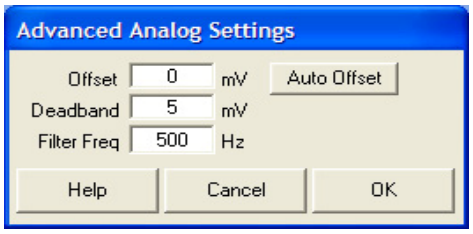
In velocity mode, the motor's speed is controlled by analog and digital inputs.



In the Velocity Dialog box, the drive is setup and all available I/O are configured.

- Checking the Use STEP input as Run/Stop will command the drive to run using a switch or signal from another electronic device. If this box is not checked, the motor will run at all times unless the Speed proportional to analog input box is checked and the analog input voltage is set at 0.
- Input DIR always controls the motor direction.
- The motor can be run at a fixed speed if a number is entered in the Speed box. Acceleration and Deceleration rates are also set here.
- When it is desired the drive to run in analog input mode, the Speed proportional to analog input box must be checked. The maximum speed corresponding to 5V analog input is set in the Speed box. When the value 10 rev/sec at +5V is set , 2.5V analog input will produce 5 rev/sec . The analog input can also change the motor direction if values are entered under the Advanced Settings tab.

Advanced Analog Settings



◇ **Offset:** When a joystick will be used to operate the drive in both directions, an offset must be entered that is half the voltage range of the joystick. If the drive's 5V output is being used to power an analog joystick, the offset should be 2.5V. The maximum speed is half the value entered in the Analog Input box above and so 2.5V analog input will correspond to zero speed.

◇ **Deadband:** When it is necessary to stop the motor with an analog signal that doesn't go to 0 volts or an offset value, (potentiometers can usually go to 0 volts, but electronic circuits usually can't), a deadband is required. This is the range of voltages in which the motor does not run and is useful for stopping the motor when the joystick is released.

◇ **Filter Frequency:** If the analog signal is noisy, the motor speed may not remain constant. Industrial systems often pick up electrical noise on an analog wire and the ST's high resolution 12-bit analog input may respond to the noise. If this occurs, the analog filter frequency should be lowered until the issue is resolved. If the frequency is set too low, the motor may change speed more slowly than specified in the acceleration and deceleration boxes due to excessive filtering.

Options for the EN Input are:

- *Change motor speed* - when the input is closed, motor will run at a different speed which must be entered in the change motor speed to box
- *Enable motor when closed* - the motor is enable when current is flowing through the input and has no power when input is open
- *Enable motor when open* - opposite of above
- *Reset alarm when closing* – an alarm or fault can be cleared by closing the input
- *Reset alarm when opening* - an alarm or fault can be cleared by opening the input
- *Not Used* – there is no function for the input, but its state can be read using the SCL IS , FS or FY command.

Options for OUT are:

- *Closed on fault* – the output will close if a fault occurs
- *Open on fault* – the output will open if a fault occurs
- *Closed to release brake* – the output controls a fail safe brake relay
- *Open to release brake* – the output opens to release the break
- *Closed when moving* – the output closes whenever the motor is moving
- *Open when moving* – the output opens whenever the motor is moving
- *Tach out* – the output produces pulses relative to the motor position
- *Not Used* – there is no function for the output , but it can be controlled using the SCL SO, FO, IH and IL commands.

SCL Mode

Here the power up mode for the drive is set correctly for use with SCL applications. SCL is MOONS' host command language for applications requiring drives to receive instructions from a host controller in real time. With SCL, drives can be operated in RS-232 mode.

Multi-axis System with MisNet Hub

This option is selected to configure the drive with the correct power up mode if a MisNet motion control hub will be used to create a multi-axis system. Hubs can be programmed as a stand alone multi axis system or as a router for SCL commands from a host system. Refer to the MisNet Hub Programmer and SCL Programming manuals for more information.

3 Error code

Status LED

The ST drives include two (red/green) LEDs to indicate status. Normal status is indicated by a green LED. If the red LED flashes, an error has occurred. The errors are indicated by combinations of red and green flashes as follows:

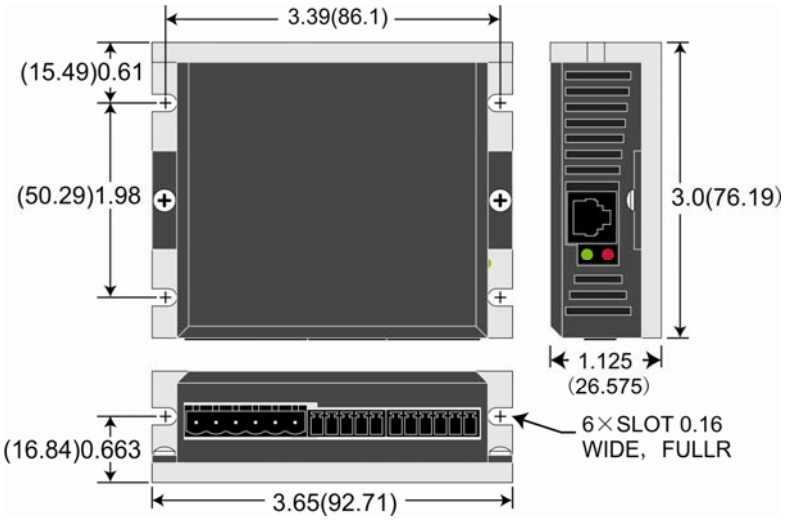
Code	Error
1 red, 2 green	attempted move while drive disabled
2 red, 1 green	ccw limit
2 red, 2 green	cw limit
3 red, 1 green	drive overheating
4 red, 1 green	power supply overvoltage
4 red, 2 green	power supply undervoltage
5 red, 1 green	over current / short circuit
7 red, 1 green	serial communication error

4 Drive mounting

MS3ST5/10-S drives can be mounted on the wide or narrow side of the chassis using #6 screws. If possible, the drive should be securely fastened to a smooth, flat metal surface that will help conduct heat away from the chassis. If this is not possible, forced airflow from a fan may be required to prevent the drive from overheating.

- Never use the drive in a space where there is no air flow or where the ambient temperature exceeds 50ºC (120ºF).
- Never put the drive where it can get wet.
- Never allow metal or otherwise conductive particles near the drive.

MS3ST5-S and MS3ST10-S



Note: inch(mm)

5 Trouble Shooting

Why does the drive indicate an over-voltage error after stopping from high speed motion?

High speed motion generates high back EMF which can be transferred to the drive and destroy it after a sudden stop. MOONS' recommends using an RC050 to protect the drive in a high speed application.

How to the function of "Electronic damping / Anti-resonance" used?

The anti-resonance feature is most effective in restraining midrange resonance of 5-20rps if the load inertia can be set precisely. If the exact inertia is unknown, the best results are achieved through experimentation.